

UDC 69.003.658.152

Using eco-development models to simulate the life cycles of the reproduction of accelerated development of industrial real estate at industrial parks

The authors address development problems of large industrial real estate facilities and their accelerated reproduction in the national market of industrial parks as the priority area of industrial construction. For this purpose, management models of life cycles focused on reducing construction time are considered as a strategic organizational and economic mechanism for the accelerated reproduction of industrial real estate facilities. The application of the concept of industrial eco-development, sustainable growth, green construction priorities, a system of tax incentives for budgets at all levels, elements of public-private partnerships and special-focus management companies responsible for the entire life cycle of these production and economic systems are considered as the key elements for reducing the life cycles of investment projects.

The relevance of this research area is determined by the significant demand for studies in the area of improving the established theoretical and practical approaches to the organization of industrial construction towards accelerating the socio-economic development of territories by means of the accelerated reproduction of large industrial real estate facilities. The innovative sector of industrial parks should boost the development of various types of industrial facilities. This process predetermines the importance of efficiently simulated life cycles of industrial parks and the accelerated reproduction of real estate as the government tool to tackle the crisis and rise the number of competitive goods. The establishment and development of the national market of industrial parks requires the development of industrial construction methods based on advanced ideas in the field of modeling the life cycles of capital construction projects, sustainable growth, ecological industrial development in relation to modern industrial construction facilities such as industrial parks.

The research objective is to develop methodological approaches and practical recommendations on simulating the life cycles of industrial parks to ensure the accelerated reproduction of the real estate based on the models of industrial eco-development and sustainable growth.

The subject of research is the development of the national market of industrial parks as a special innovative market segment of industrial construction focused on the accelerated reproduction of industrial real estate in the context of the need to reduce the implementation term of these investment projects.

The article demonstrates the following research results: development trends of the national market of industrial parks; organizational and economic mechanisms underlying the establishment and growth of the market of industrial parks in Russia and worldwide; structurization and analysis of organized impacts related to the state priorities in respect of the nation-wide establishment and development of industrial parks; the track record of application of the concept of sustainable growth and eco-development to industrial construction and the practice of building industrial parks; simulating the life cycle of industrial real estate in the context of its accelerated reproduction using the tools of industrial eco-development and sustainable growth; formalizing the multicomponent sustainability indicators of life cycles of industrial parks and their eco-development; the economic and mathematical interpretation of projected sustainability values for the life cycles of industrial eco-development as the economic reliability of reproduction processes in industrial construction exemplified by Severny Almaz industrial park at the early stages of its planning.

Keywords: modeling, life cycles, accelerated reproduction, industrial parks, industrial construction, industrial real estate, sustainable growth, eco-development, public-private partnership, economic reliability, brownfield, greenfield

Acknowledgements. The research was supported by the Russian Science Foundation grant No. 22-28-20511.

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INTRODUCTION

1.1. OVERVIEW OF THE SITUATION

The analysis of present-day features of industrial construction and its development in Russia and abroad indicates that its special innovative segment — the market of industrial parks — is in the process of establishment and development. This market segment should be attributed to an actively developing type of industrial construction, capable of boosting the industrial potential in communities and countries due to special management techniques applied in the course of building industrial parks. Hence, problems of accelerated reproduction of large indus-

trial real estate facilities can be formulated and solved.

The task of modeling national strategies towards accelerating the socio-economic development of countries and communities using organizational and economic mechanisms focused on the accelerated reproduction of industrial real estate through tighter deadlines set for these types of investment projects has proven to be particularly relevant. The current global trend in the management of capital construction facilities is life cycle management. In this regard, the study examines management models for the accelerated establishment of industrial facilities by means of setting tighter deadlines.

► The application of the concept of industrial eco-development, sustainable growth, the green construction priority, the system of taxation benefits at all levels, elements of the public-private partnership are considered as the key elements of accelerated construction of industrial facilities.

It is also important to ensure efficient organizational management structures based on the establishment of management companies included in the public-private partnership system responsible for the operation of the whole life cycle of these production and economic systems that have elements of tax benefits for residents.

The scope of problems confirms the relevance of this area of research. There is a significant demand for studies in the field of improving the established theoretical and practical approaches to industrial construction, and its rising performance can accelerate the socio-economic development of areas.

Hence, the national market of industrial parks requires the development of industrial construction methods based on the advanced ideas of modeling the life cycles of capital construction facilities, sustainable growth, industrial eco-development in relation to cutting-edge industrial parks and special economic zones.

1.2. REVIEW OF LITERATURE

The legal framework allows industrial parks to become lucrative for investments through special customs procedures, taxation and labour legislation^{1, 2, 3}. As a result, the range of support extended to industrial parks reduces investment payback terms two-fold. The efficiency of industrial parks and their development in Russia is confirmed by individual studies [2], while the statistics available on the website of the Association of Russian Industrial Parks⁴ has proven a steady growth in the number of industrial parks in the country from 80 in 2013 to 334 in 2020. At the same time, the number of jobs has grown from 56,773 to 185,395 at the annual growth rate of 18.4 %, and the increase in the number of residents has grown from 958 to 3,498 featuring an average annual growth rate of 20.3 %. The total amount of investments made in industrial parks in 2020 reached to 1.6 trillion rubles, which is twice the amount invested in 2013.

The review of the international experience, accumulated by the United Nations in applying the concept of sustainable development to sustainable development objectives⁵, the analysis of the report on Russian sustainable development objectives issued by the analytical centre of the Government of the Russian Federation⁶, the analysis of sustainable development implementation mechanisms [2], as well as present-day regulatory requirements for urban planning⁷ and other sources indicate a new organizational stage in the

development of industrial construction. This stage can be defined as the stage of sustainability assurance through the modeling of sustainable eco-development of areas designated for the reproduction of industrial real estate.

This global trend determines the priority of managing the sustainability of national development from the standpoint of building competitive industrial potential on the basis of the effective reproduction of cluster-oriented portfolios of industrial real estate. In this regard, the development of the industrial construction market is of great importance in the context of promotion of industrial parks as an effective form of fundraising in the sector of clustered portfolio systems focused on industrial real estate.

This type of industrial construction market is a special model of project financing; it contains elements of public-private partnership employed to finance the engineering infrastructure of industrial construction sites, as well as related tax benefits for residents.

The priority of sustainable (green) development is confirmed by the relevant Government Decree No. 1587 of September 21, 2021⁸, which approves of the green project financing criteria and initiatives in the field of sustainable development. This Decree defines the green terminology and the following concepts: a sustainable development project; a portfolio of sustainable development projects; a green financial instrument and others.

It's worth mentioning that according to Order of the Government of the Russian Federation [11] dated July 14, 2021 No. 1912-r, national goals and main directions of sustainable (green) development of the Russian Federation include investment activities in the field of construction, that encompasses industrial real estate and industrial construction.

Two types of projects are suggested as the basis for investments in the field of sustainable development. Firstly, this is a "green project" that is in line with all principles of sustainable development specified in paragraph 2 of the above-mentioned decree issued by the Government of the Russian Federation. Secondly, the "adaptation project" that is in line with one or more directions set by Order No. 1912-r issued by the Government of the Russian Federation on September 14, 2021⁹.

The Russian Federation plans to use VEB.RF state development corporation as the main "methodological centre" for sustainable development. According to the federal legislation¹⁰, this corporation is responsible for the methodological support in the field of investment activities in sustainable (green) development and contributing non-budgetary funds to relevant projects. VEB.RF state development corporation is empowered to co-manage development institutions and social entrepreneurship in Russia.

1 About Industrial (Industrial) Parks and Managing Companies of Industrial (Industrial) Parks : Order of the Government of the Russian Federation as of August 4, 2015 No. 794.

2 About Industrial Policy in the Russian Federation : Federal Law as of December 31, 2014 No. 488-FZ.

3 About strategic planning in the Russian Federation : Order of the Government of the Russian Federation as of October 30, 2014 No. 1119 and of August 11, 2015, No. 794, FZ-172 of June 28, 2014.

4 Association of industrial parks of Russia. URL: https://indparks.ru/upload/iblock/5b4/Blok2021_WEB_4.compressed.pdf (Accessed: February 23, 2022)

5 Sustainable development goals. URL: <https://www.un.org/sustainabledevelopment/ru/sustainable-development-goals/>

6 Sustainable development goals. UN and Russia : the human development report in the Russian Federation. S.N. Bobyllov, L.M. Grigoriev's (ed.); the publishing editor A.V. Golyashev. Moscow, Analytical Centre under the Government of the Russian Federation, 2016; 293.

7 Town-planning Code of the Russian Federation: the text amended and revised in 2021. Moscow, Eksmo Publ., 2021; 448.

8 On approval of criteria of sustainable development projects (including green) in the Russian Federation and requirements to the system of verification of sustainable development projects (including green) in the Russian Federation : Order of the Government of the Russian Federation as of September 21, 2021 No. 1587. URL: <http://government.ru/docs/all/136742/> (Accessed: February 23, 2022).

9 The national goals and the main directions of sustainable (including green) development of the Russian Federation : Order of the Government of the Russian Federation of July 14, 2021 No. 1912-r. URL: <http://government.ru/docs/42795/> (Accessed: February 23, 2022).

10 About the state corporation of development "VEB.RF" amended and revised, in accordance with the Federal Law No. 332-FZ of July 2, 2021 "On amendments to certain legislative acts of the Russian Federation and recognizing void Part 11 of Article 8 of the Federal Law «On the innovation center Skolkovo»" : The Federal Law of May 17, 2007 No. 82-FZ. URL: <http://pravo.gov.ru/proxy/ips/?docbody=&firstDoc=1&lastDoc=1&nd=602263689> (Accessed: February 23, 2022).

Hence, the analysis of contemporary national development trends indicates that the key strategic area of industrial real estate reproduction, being a booster of the socio-economic development, is the preparation and implementation of investment projects and programmes of this type from the standpoint of the sustainable development paradigm based on "green projects" or "adaptation projects".

This scope of problems determine the need to improve the established models of industrial real estate development from the standpoint of using all criteria of green and adaptation projects within the framework of verification of sustainable (green) development projects in the Russian Federation. The task of allocating and using innovative funding for these types of projects, including the use of non-budgetary sources through the issuance of "green bonds", loans or credit lines, is fully justified and acceptable.

These prerequisites determine the need to improve the accelerated construction of all types of industrial facilities, including industrial parks and industrial zones in the context of benefits to be provided through structuring sustainable local business systems of industrial construction as a special type of operating models of ecological industrial development based on the principles of sustainable and green performance.

This move determines the need for theoretical and practical research in the field of the concept of relevant sustainable development with the focus on the accelerated reproduction of industrial real estate facilities based on the ideology of industrial eco-development.

This is especially important from the standpoint of the national environmental industrial construction standard, applied to construction of industrial parks. This trend is relatively new for Russia, but the need for a nationwide environmental standard for industrial construction is becoming more and more obvious every year. This scope of problems manifests itself in the lack of a unified eco-development assessment system both in terms of design, construction and operation according to urban planning regulations. There is also no unified legal framework for the large-scale implementation of eco-development and green construction principles. Problematic issues include the inevitable increase in the cost of industrial construction projects, which is boosted by supplementary eco-development requirements. This, of course, requires new approaches to the effectiveness of green building innovations and the importance of designing competitive eco-systems in the sector of industrial parks and their development.

A review of several studies in the field of eco-development, green construction in Russia [3–8], global practices in construction and architecture [9–15] shows that despite the views expressed by a number of researchers, industrial eco-development is the least developed area of commercial real estate development, especially in view of its applicability to the national market of industrial parks. The review proves that the assessment of the cost of life cycles of investment facilities in industrial parks should be considered promising from the viewpoint of the ownership costs for ultimate consumers, as well as the importance of competitive evaluation of eco-oriented life cycles of capital construction projects [16, 17].

In Russia, eco-construction is at the start, whereas in the USA it has already captured 20 % of the market, in Europe — about 15 %, in Russia — less than 1 % so far.

One of the main factors restraining its development is the cost of certification, that the Russian developers do not consider appropriate. Also, eco-friendly building materials, authorized by "green" standards, significantly increase project investment costs. In this

regard, the promotion of "green" construction in Russia is a relevant issue in line with global contemporary trends in the development of the construction industry.

The development of the national market of industrial parks and special economic zones, despite its obvious achievements, has great potential for growth from the perspective of the issues studied in this article. This fact has predetermined the objective of the study, that is, to develop the methodological approaches and practical recommendations on the simulation of the life cycles with a view to the accelerated reproduction of industrial real estate in industrial parks using models of industrial ecological and sustainable development.

2. METHODS

The implemented research project has allowed the authors to make a conclusion that the key criteria used in the functional and structural modeling of life cycles of industrial construction projects at industrial parks (IP), considered as eco-development systems (GD_{ip}), should be formalized with the help of a life cycle system of these types of capital construction projects.

A three-dimensional model of a system, consisting of a set of functions, is employed as the backbone for modelling the life cycle of industrial eco-development construction projects at industrial parks (GD_{ip}). They should be considered as targets or local results needed to ensure better ecological and economic performance of this system at each stage of the GD_{ip} life cycle.

The authors believe that the efficiency and organizational economic reliability of GD_{ip} processes should be determined from the viewpoint of organizational economic stability of reproduction processes at the minimum ownership cost of a portfolio of industrial real estate, considered as part of the IP for residents who may be owners or tenants.

The research paradigm, applied by the authors, has proven the feasibility and prospects of analyzing the life cycle of IP's industrial eco-development as a functional and reliable system consisting of:

- *firstly*, stages in the life cycle of industrial eco-development ($ZI-j$), as the basis for structurization and simulation of life cycles dealing with the management of this innovative type of industrial development. The number of ($i-j$) stages here is the subject of projections and methodological modeling;
- *secondly*, local functional tasks of industrial eco-development L_i . In this study, the author considers them as solutions to local problems or as a route towards cumulative integral results. Functional tasks generate the environmental integrity or "greenness" of any subsystem in GD_{ip} development life cycles.

The authors propose to use G1 criteria included into the following 9 basic subsystems treated as key green functional eco-development indicators: eco-functions of environmental management, environmental design solutions towards the optimization of eco-requirements and their implementation; G2. Eco-functions focused on infrastructure and environmental quality, as well as their implementation; G3. Eco-functions in the field of architectural, space-planning and design solutions and their implementation; G4. Eco-functions in the field of thermal, light, and acoustic comfort and the indoor environment; G5. Eco-functions in the field of sanitary protection, its quality and waste disposal; G6. Eco-functions in the field of rational water use and regulation of wastewater disposal; G7. Eco-functions in the field of energy saving and energy efficiency (Reduction of heat energy consumption for heating and ventilation of buildings; reduction of heat energy consumption for hot water

- supply; reduction of electricity consumption; reduction of specific total primary energy consumption by engineering systems; use of secondary energy resources); G8. Eco-functions focused on environmental protection in the process of industrial construction and subsequent demolishing of capital construction facilities in order to minimize the impact of materials used in construction, waste generation during construction work, as well as the implementation of measures to protect and restore the environment during construction; G9. Eco-functions ensuring life safety, or backup power, water and heat supply infrastructure, as well as other elements of industrial, transport, social and logistics infrastructure of industrial parks;
- *thirdly*, there are eight levels of managing the eco-development of industrial parks: ω_1 — state management at the Federal level; ω_2 — state management at the level of a subject of the Russian Federation; ω_3 — municipal level; ω_4 — management

of individual specialized IP projects; ω_5 — IP management against the background of special economic zones; ω_6 — procedural IP management based on national and global standards; ω_7 — managing the expansion of the system of industrial eco-development based on business partnerships and consortia; ω_8 — the business process level of investment project management;

- *fourthly*, large industrial structures as a special type of reproduction and a cluster portfolio of reproduced types of industrial real estate (KPx).

The author has elaborated a fundamental functional model for the eco-development of life cycles of industrial parks (GD_{ip}), which is defined as a dynamically adaptive structure composed of consolidated interacting local functional-target subsystems:

$$[GD_{ip}^{0:t}] = f \left[\left[(Z^{t-j}) \cap (L_i) \cap (KP^x) \right] \cap \left[(\omega_i - j) \cap (G^{1-9}) \right] \right] \rightarrow (E_{ij}^{nm}, E_{PDij}^{s.f}, R_{pd}) \rightarrow (C_{own}^{min}), \quad (1)$$

where E_{ij}^{nm} is the organizational and economic reliability of life cycles of IP industrial construction that demonstrates a maximizing tendency; $E_{PDij}^{s.f}$ is the organizational and economic stability of operation of an industrial eco-development system that demonstrates a maximizing tendency; R_{pd} — total productiveness GD_{ip} tend to maximum R_{pd}^{max} ; P_{pd} — общая результативность GD_{ip} , стремящаяся к максимуму R_{pd}^{max} ; R_{pd}^{max} is the total GD_{ip} performance that demonstrates a maximizing tendency; C_{own}^{min} is the total cost of industrial real estate as part of IP ownership.

Taking these principles into account, the eco-development of an industrial park must be considered as a set of Z^j functions used for life cycle simulation purposes. This approach is based on the proposed mode of operation of an industrial eco-development system (GD), that encompasses the subsystems of land development (DL), investment and construction development (redevelopment) (RD), development of engineering infrastructure (DI), development of transport infrastructure (DTI); operational development (OD).

The quantitative assessment of criteria applied to the reliability of organizational and economic constructions within the GD_{ip} industrial eco-development system is technically defined by the authors as the extent of mutual compliance between key investment decisions consistently designed and implemented by a corporate developer (management company) at various stages of the $GD_{ip}^{0:t}$ life cycle.

The author suggests using the T. Saati method to determine the integral value of organizational and economic reliability E_{ij}^{nm} of economic activities conducted by the developer and the general contractor. Within the framework of this approach, an appropriate methodological apparatus has been worked out to quantify the efficiency of the $GD_{ip}^{0:t}$ operation.

3. RESULTS

3.1. CONCEPTUAL IDENTIFICATION

Industrial eco-development (GD_{ip}) of industrial parks should be understood as the professional activity of a specialized developer, or contractor acting in the capacity of a special management company involved in the public-private partnership, eco-development and sustainable development.

It accelerates the construction of industrial complexes, establishment of target corporate alliances between business partners (construction, logistics, transport, operational, etc. companies)

united by the process of eco-friendly reproduction of industrial real estate, including land and real property (portfolios).

At the same time, the target criterion for the efficient accelerated reproduction of large complex industrial facilities is the maximum ecological and economic efficiency at the minimum total cost of industrial real estate ownership for various residents.

3.2. THE NATIONAL MARKET OF INDUSTRIAL PARKS: DEVELOPMENT TRENDS

The analysis of statistical data published on the website of the Association of Industrial Parks of Russia [5] shows a steady trend in the development of this market segment featuring average annual growth of about 23 % per year (Fig. 1). At the same time, industrial parks were established in 2020 in 66 regions, which means a two-fold increase compared to 2013.

At the same time, the capacity of the market of national industrial parks increased from 789 billion rubles in 2013 to 1,682.0 billion rubles in 2020 (Fig. 2) featuring a total growth index of 2.1 times for this period and an average growth index of 14.2 % per year. The graph shows the trend of changes in the total amount of investments, including the production and industrial infrastructure.

A steady trend in the development of industrial parks is also backed by the growth in the number of jobs and the total area of industrial parks in operation (Fig. 3).

The analysis shows that the number of jobs rose from 16,315 in 2013 to 41,627 in 2020 with an average annual growth rate of about 20 %.

Also, the total areas of existing parks demonstrates an average annual increase of 24 %. It grew from 56,773 ha in 2013 to 165,395 ha in 2020.

The breakdown of industrial parks by their types shows that the Greenfield type of industrial parks is predominant in Russia (Fig. 4). The current growth rate is about 60 %.

Most industrial parks are private in Russia (about 70 % as of 2020). The efficiency of investments in industrial parks is in line with the ratio of infrastructural costs to production investments that equals to 1 to 10.

The study of these and other data has proven the success of the national market of industrial parks. It is assumed that its current growth may be limited to 300, and this number will meet the current demand for this type of industrial construction work.

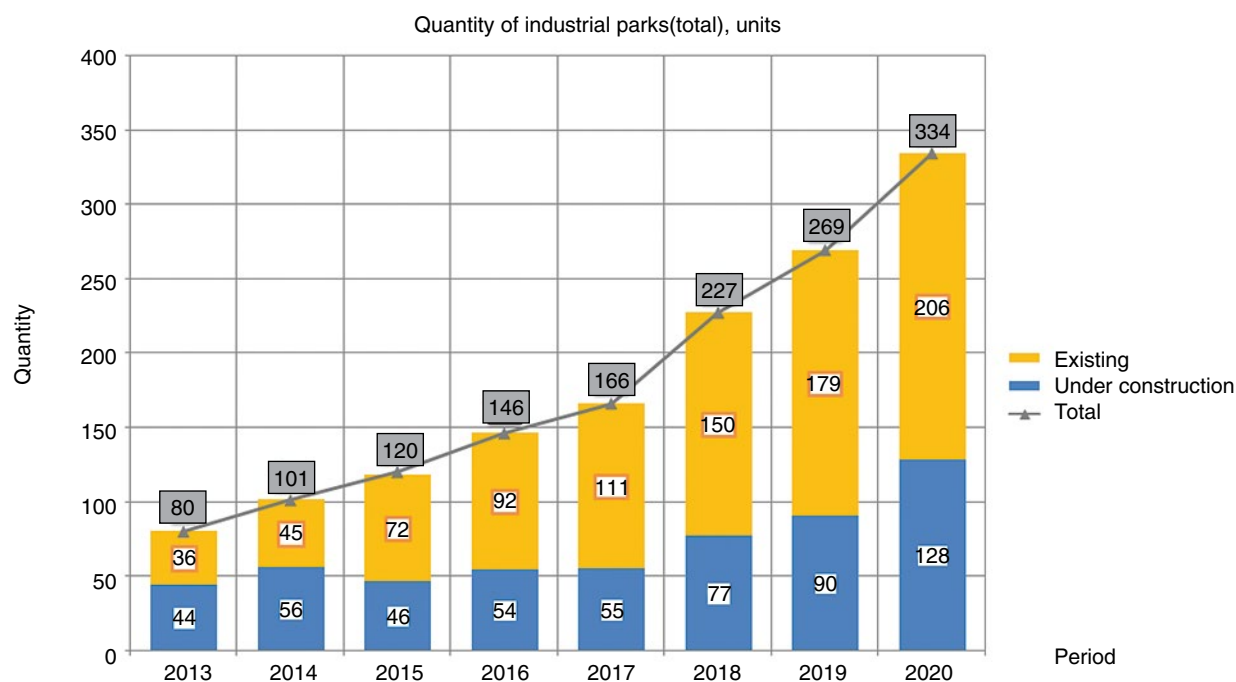


Fig. 1. The number of industrial parks in Russia in 2013–2020

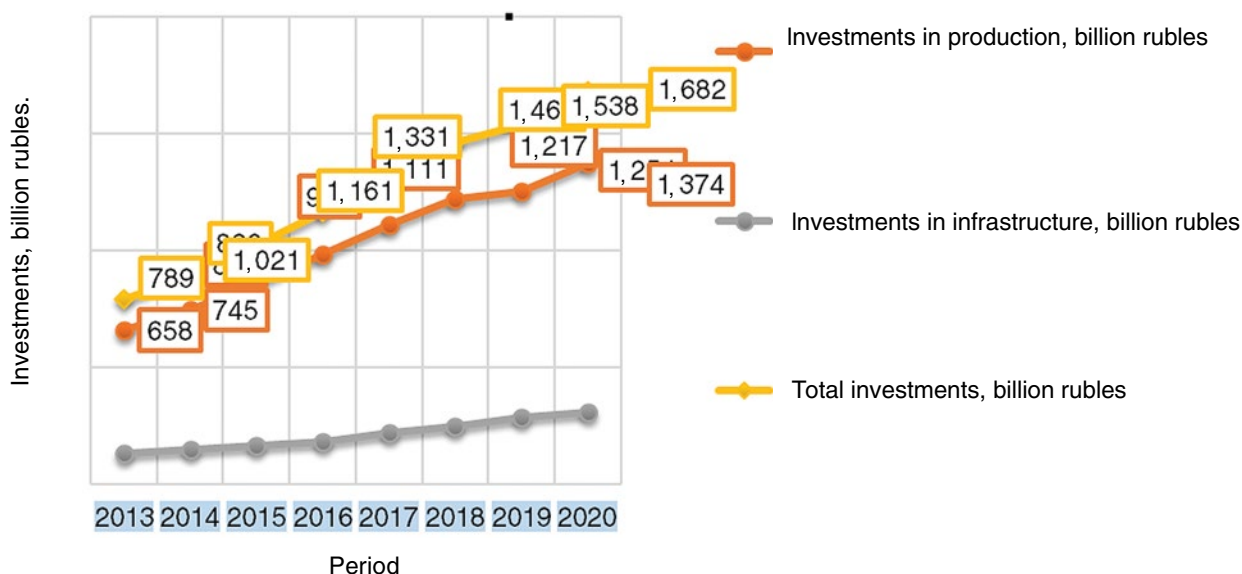


Fig. 2. The capacity of the national market of industrial parks in the Russian Federation, in billion rubles

3.3. PROJECTED PERFORMANCE INDICATORS OF THE LIFE CYCLE OF INDUSTRIAL ECO-DEVELOPMENT BASED ON THE INDICES OF ORGANIZATIONAL AND ECONOMIC STABILITY

When adding eco-development functions to the GD_{ip} life cycle system, new methodological approaches were pilot-tested at Severynnyy Almaz industrial park, designed in the East Siberian region.

It is assumed that the mini-max criterion can ensure the maximally efficient accelerated construction of large industrial facilities of industrial parks. Hence, efficiency is maximized, and the cost of ownership of industrial real estate (C_{own}) in industrial parks is minimized for residents.

The calculation of organizational and economic stability of the $GD_{ip}^{0:t}$ of an IP system at the Z^{IV} stage relative to the single basic value of the S_{stb}^0 at the Z^I stage was adopted as the final projected indicator of the operating efficiency of eco-development of industrial parks.

In the calculations, this indicator is defined as a system for evaluating mutual correspondences III-II and III-I using the multiplier of 0.9. Two methods were applied to identify the system of correspondences. First, duration indicators (T) were used. Then the value of investments (V) was applied. The values can be illustrated by the following calculations that use the data as a system of S_{stb}^0 (III-II):

- $S_{sib}[T] = \{T(0)[Z^I] = 5.25 \text{ years}\} / \{T(0)[Z^{II}] = 7.75 \text{ years}\} = 0.72$;
- $S_{sib}[V] = 0.85$;
- $S_{sib}^0 [F_E D^{II-III}] = 0.72 \cdot 0.85 = 0.61$.

In accordance with the calculations made for the first stage of industrial construction within the framework of an IP:

$$P_{PD(I)}^{norm} = 0.9 \cdot 1.1 \cdot 1.2 \cdot 1.1 \cdot 1.8 \cdot 1.25 = 2.822,$$

which consists of seven local performance subsystems: $R_j^{rel} = 0.9$ (organizational and economic reliability of construction in $GD_{ip}^{0:t}$); $B_j = 1.2$ (business activity); $PI_j = 1.1$ (potential intensity); $I_j = 1.1$ (innovation); $SP_j = 1.8$ (system performance); $PR_j = 1.25$ (profitability); $EP_j = 1.3$ (environmental potential of IP investment projects).

$P_{PD(I)}^{act} = 2.912$, i.e. the actual management efficiency of $GD_{ip}^{0:t}$ exceeds 3 %.

Jobs created in industrial parks

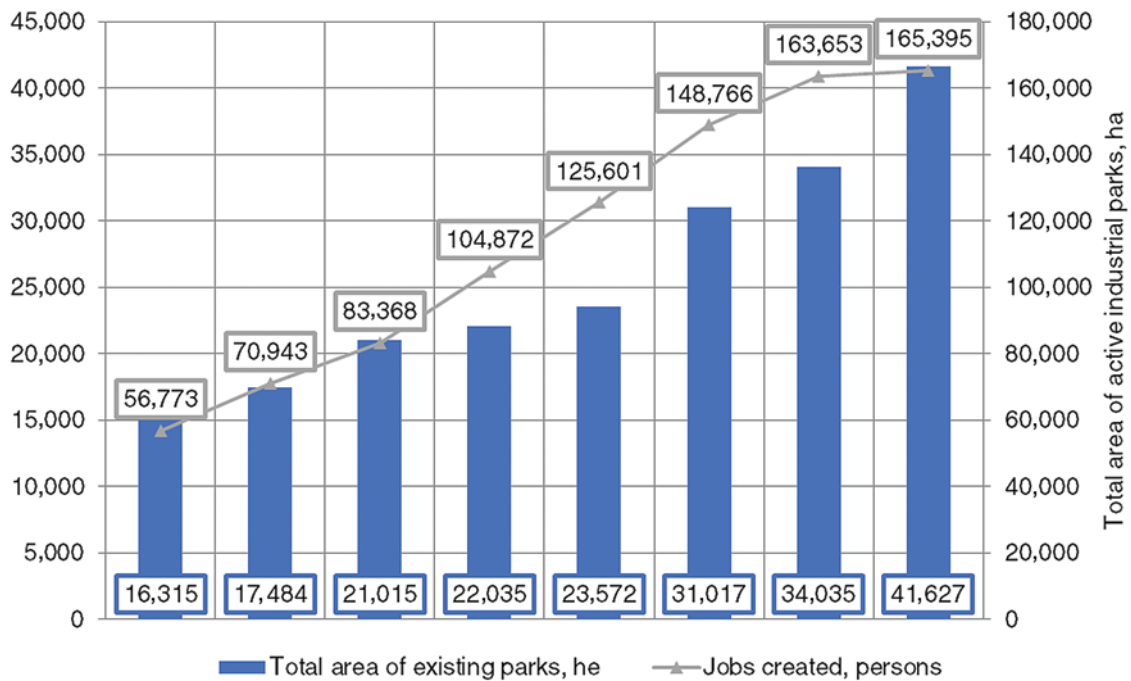


Fig. 3. The growing number of jobs and the total area of industrial parks in operation (hectares)

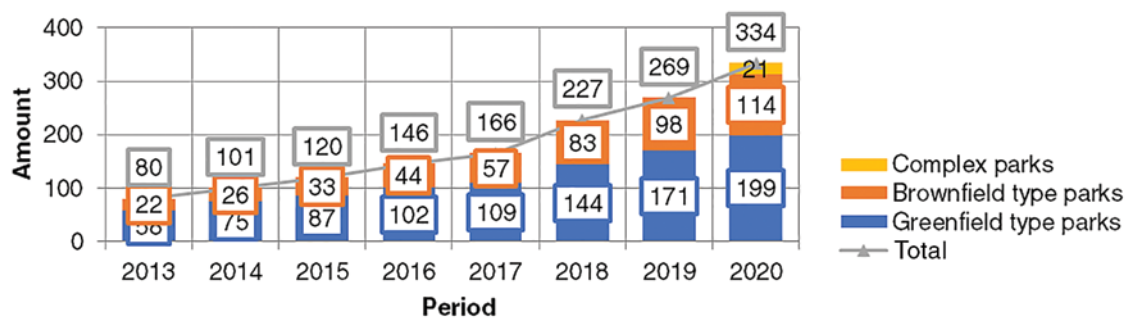


Fig. 4. A change in the number of industrial parks broken down by the types, including Brownfield, Greenfield and integrated ones

$C_{own}^{norm} = 10.378$ billion rubles; $C_{own}^{act} = 10.134$ billion rubles, which corresponds to the theory of correlation between performance ($P_{PD(I)}$) and the total cost of ownership (C_{own}) used in the study.

The pilot-testing of this technique is experimental and incomplete due to problems in collecting some of the data. The interpretation of the obtained results and the essence of the methodology require further development and do not aspire to be complete.

4. DISCUSSIONS

It is proven that the attempt to simulate the market of industrial parks from the viewpoint of eco-development, sustainable development and the structure of the life cycle of accelerated construction of large industrial facilities should be recognized as a very relevant and very difficult theoretical and practical task which predetermines the further development of this methodological approach.

Debatable issues are:

1. The need for a more detailed study of environmental standards applicable to the eco-development of four types of industrial parks: a private industrial park of the Greenfield type; a private industrial park of the Brownfield type; a state industrial park of the Greenfield type; a state industrial park of the Brownfield type;
2. The importance of additional research needed to substantiate industrial eco-development modeling applied to private and public IP models.
3. The application of the effectiveness theory requires additional adjustments in terms of singling out its local subsystems and the mechanism of their integrative synthesis in a single indicator.
4. Indicators of ecological and economic efficiency require further development from the standpoint of national and international rankings of greenness and sustainability.
5. It is assumed that a promising area of research is the need for more detailed studies on the theory of the ownership cost of industrial real estate for industrial parks residents, as well as the importance of calculating the cost of life cycles of these types of real estate for all periods of ownership for residents.

The above mentioned controversial issues dealing with the methodology should be regarded not so much as the shortcomings, but as the prospects for its development.

5. CONCLUSIONS

The research, conducted by the authors, has proven the importance of their approach to the theoretical and practical research into the methodology and practical recommendations concerning the simulation of life cycles of accelerated reproduction of real estate at industrial parks using models of industrial eco-development and sustainable development.

The study on specific development features of the market of national industrial parks has allowed to formulate the scope of problems and identify the main trends in the development of this type of market, confirming its steady growth, boosting the industrial potential of the country and its certain area through high-performance and high-speed industrial construction.

The studies identify the economic essence of industrial parks, their eco-development as a specialized professional activity of a developer acting as a special management company engaged in the public-private partnership, eco-development and sustainable development.

This procedure generates an additional value chain for resident investors who benefit from the integral result, or the accelerated construction of large industrial facilities featuring the environmental priority of green projects.

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Моделирование жизненных циклов ускоренного развития воспроизводства промышленной недвижимости в индустриальных парках на основе моделей экodeвелопмента

Исследована проблематика формирования ускоренного воспроизводства крупных комплексов промышленной недвижимости на национальном рынке индустриальных парков как

особо приоритетного сегмента промышленного строительства. При этом в качестве стратегического организационно-экономического механизма ускоренного воспроизводства данных объектов промышленной недвижимости рассматриваются модели управления на основе жизненных циклов с целевыми функциями сокращения сроков строительства. В качестве ключевых элементов регулирования сокращения продолжительности жизненных циклов реализации данных инвестиционных проектов рассматриваются применение

концепции экологического промышленного деvelopeмента, устойчивого развития, приоритета зеленого строительства, системы налоговых преференций бюджетов всех уровней, элементы государственно-частного партнерства и формирование специализированных управляющих компаний, ответственных за весь жизненный цикл функционирования данных производственно-экономических систем.

Актуальность данной области разработок определяется значительной востребованностью исследований в области совершенствования существующих научно-практических подходов в области организации промышленного строительства, ответственного за ускорение социально-экономического развития территорий на основе ускоренного воспроизводства крупных промышленных комплексов недвижимости. Формирование инновационного сегмента промышленного строительства в виде рынка индустриальных парков должно обеспечить ускоренное создание промышленных комплексов различного типа. Это предопределяет важность эффективного моделирования жизненных циклов ускоренного воспроизводства промышленной недвижимости индустриальных парков как антикризисного инструментария государственного регулирования наращивания конкурентоспособных товаров. Создание и развитие национального рынка индустриальных парков требует развития методов промышленного строительства на основе современных идей в области моделирования жизненных циклов объектов капитального строительства, устойчивого развития, экологического промышленного деvelopeмента применительно к современным формам промышленного строительства в виде индустриальных парков.

Целью исследования является разработка методических подходов и практических рекомендаций по моделированию жизненных циклов ускоренного воспроизводства промышленной недвижимости индустриальных парков на основе моделей промышленного экологического деvelopeмента и устойчивого развития.

Объектом исследования является развивающийся национальный рынок индустриальных парков как особый инновационный сегмент промышленного строительства, ориентированный на ускоренное воспроизводство промышленной недвижимости в условиях необходимости существенного сокращения сроков реализации данных типов инвестиционных проектов.

В статье продемонстрированы следующие основные научные результаты: тренды развития национального рынка индустриальных парков; особенности организационно-экономических механизмов становления и развития рынка индустриальных парков в России и за рубежом; структуризация и анализ методов организационного воздействия, связанных с государственными приоритетами национального становления и развития индустриальных парков; опыт применения концепции устойчивого развития и экологического деvelopeмента применительно к промышленному строительству и практики строительства индустриальных парков; авторское моделирование структуры жизненного цикла ускоренного воспроизводства промышленной недвижимости при промышленном строительстве индустриальных парков на основе инструментария промышленного экологического деvelopeмента и устойчивого развития; формализация многокомпонентных показателей устойчивости жизненных циклов экологического деvelopeмента индустриальных парков; экономико-математическая интерпретация прогнозируемых показателей устойчивости жизненных циклов промышленного экодеvelopeмента как экономической надежности производственных процессов промышленного строительства применительно к индустриальному парку «Северный алмаз» на ранних стадиях его планирования.

Ключевые слова: моделирование, жизненные циклы, ускоренное воспроизводство, индустриальные парки, промышленное строительство, промышленная недвижимость, устойчивое развитие, экологический деvelopeмент, государственно-частное партнерство, экономическая надежность

Благодарности. Исследование выполнено при поддержке гранта Российского научного фонда № 22-28-20511.

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For citation: Volgin V.V., Baronin S.A. Using eco-development models to simulate the life cycles of the reproduction of accelerated development of industrial real estate at industrial parks. *Real estate: economics, management*. 2022; 1:23-31.

Для цитирования: **Волгин В.В., Баронин С.А.** Using eco-development models to simulate the life cycles of the reproduction of accelerated development of industrial real estate at industrial parks // *Недвижимость: экономика, управление*. 2022. № 1. С. 23–31.



Л.И. Павлова. Москва. Казанский вокзал. Рисунок, тушь, перо.